Calibration and Validation of SARAL/AltiKa Geophysical Products

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SARAL/AltiKa NRT Verification
Workshop Toulouse, France

AltiKa onboard SARAL (Satellite for ARgos and ALtiKa), a joint ISRO-CNES effort is the first milestone of high frequency radar altimetry. **SARAL satellite was lauched on 25, February, 2013 from SHAR**

AltiKa Payload contains

- **Ka Band altimeter with enhanced bandwidth of 500 MHz**
- **Dual Frequency radiometer (27/37 GHz)**
- **Laser Retro-reflector Array**
- **DORIS**

Products derived from SARAL AltiKA

- **Range along with known geoid is used to derive Sea Surface Height (SSH)**
- **Slope of leading edge of Wave Form is used to estimate Significant Wave Height (SWH)**
- **Strength of returned power used for estimation of wind speed**

Required accuracies of the products at various stages of data product

Parameter	OGDR	IGDR	GDR	Goal
Significant Wave height (SWH)	0.5 m	0.4	0.4	0.25m
Sea Surface Height Anomaly (SSHA)	30.5cm	5.3 cm	4.6cm	2-3cm
Wind Speed	2m/s	1.7 m/s	1.7 m	1m/s

Rationale of the study

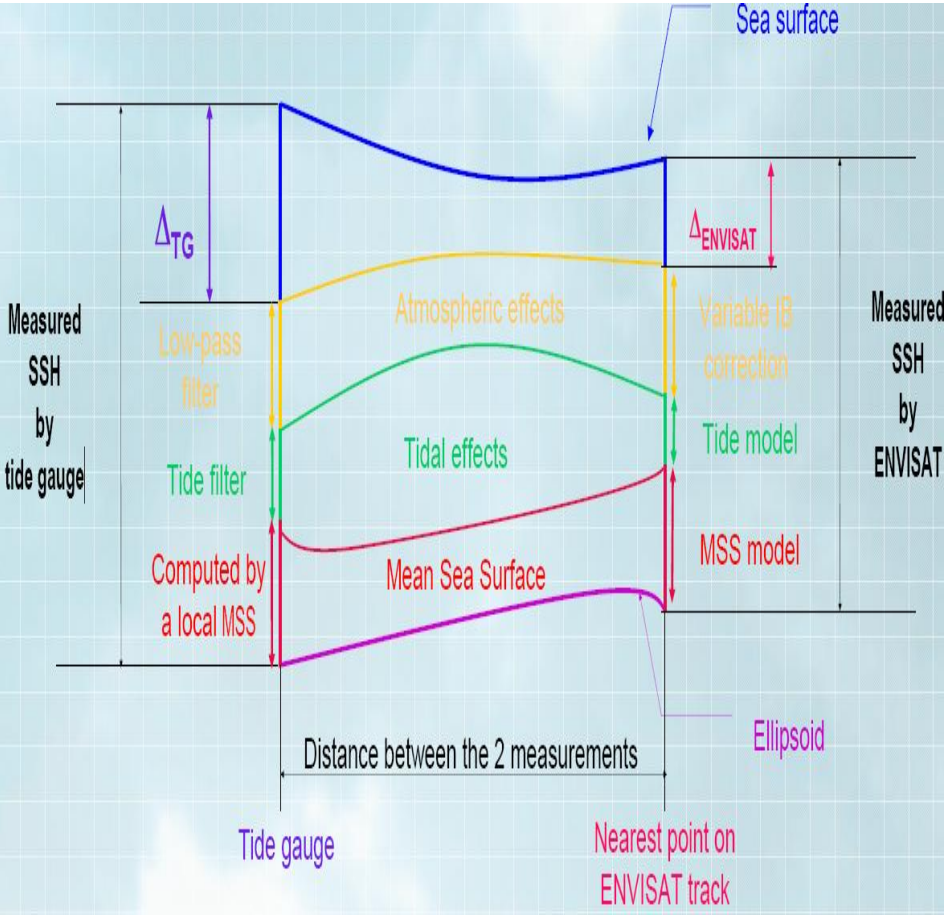
Orbit precession of altimeters often changes during in-flight phase due to hostile environment in space. It affects accuracy of measurements . Due to this, accuracy of all other geophysical products derived from altimeter measurements are affected. Thus in-flight calibration of altimeter measurements and validation of geophysical parameters is needed to check if their errors are within the pre-defined range or not.

Data Used:

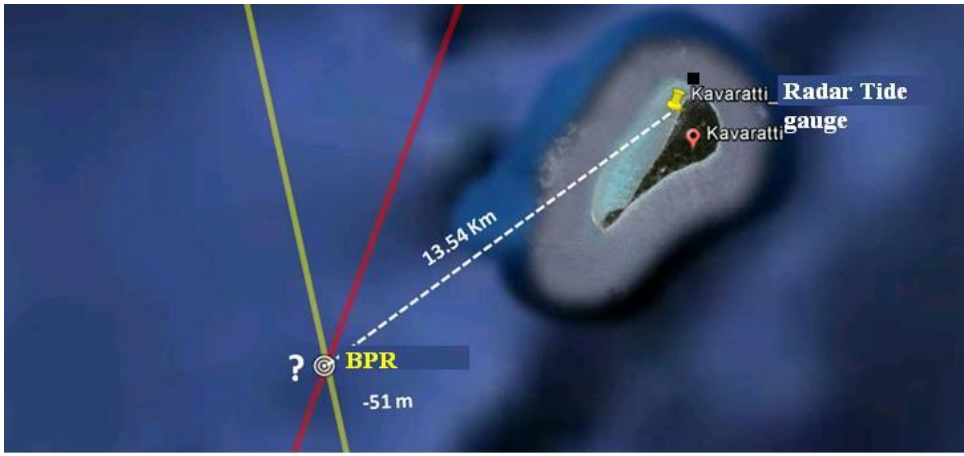
- ✓ *In-situ tide gauge measurements of SSH at absolute calibration site in Kavarati (March-June,2013).*
- ✓ *Jason-2 OGDR, IGDR and GDR products (March-June,2013).*
- ✓ *In-situ measurements from NDBC Buoy Data (March-June,2013).*
- ✓ *SARAL /AltiKa OGDR, IGDR and GDR products.*

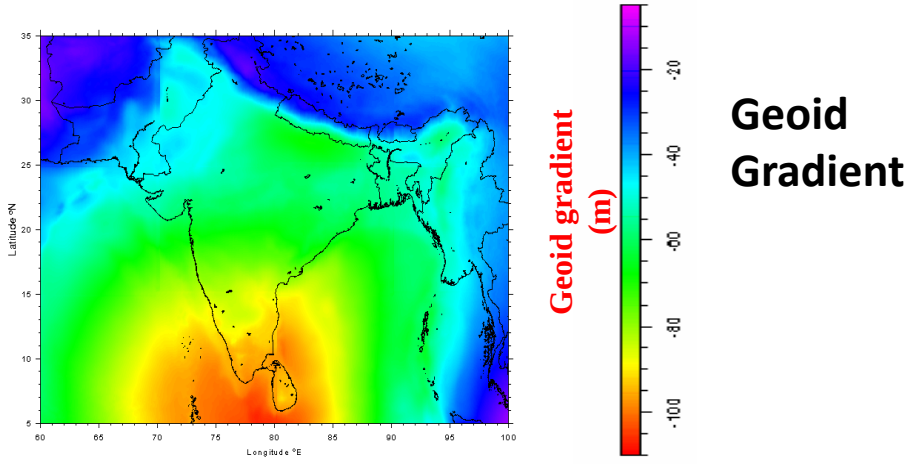
SARAL AltiKa: Calibration at Indian Site

Calibration Method



Absolute Calibration Site in India

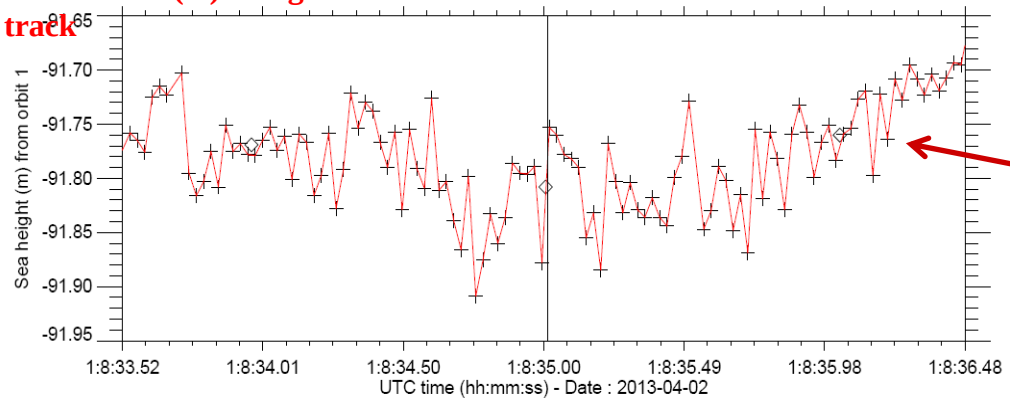


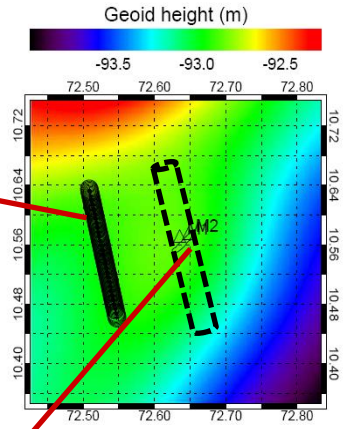


Geoid Gradient

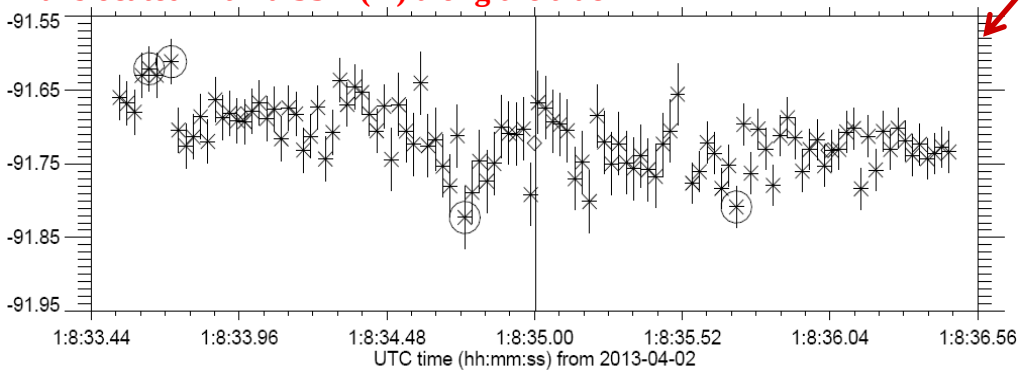
SARAL AltiKa SSH Calibration at Indian Site Kavaratti

AltiKa SSH (m) along the track





Translocated AltiKa SSH (m) along the track

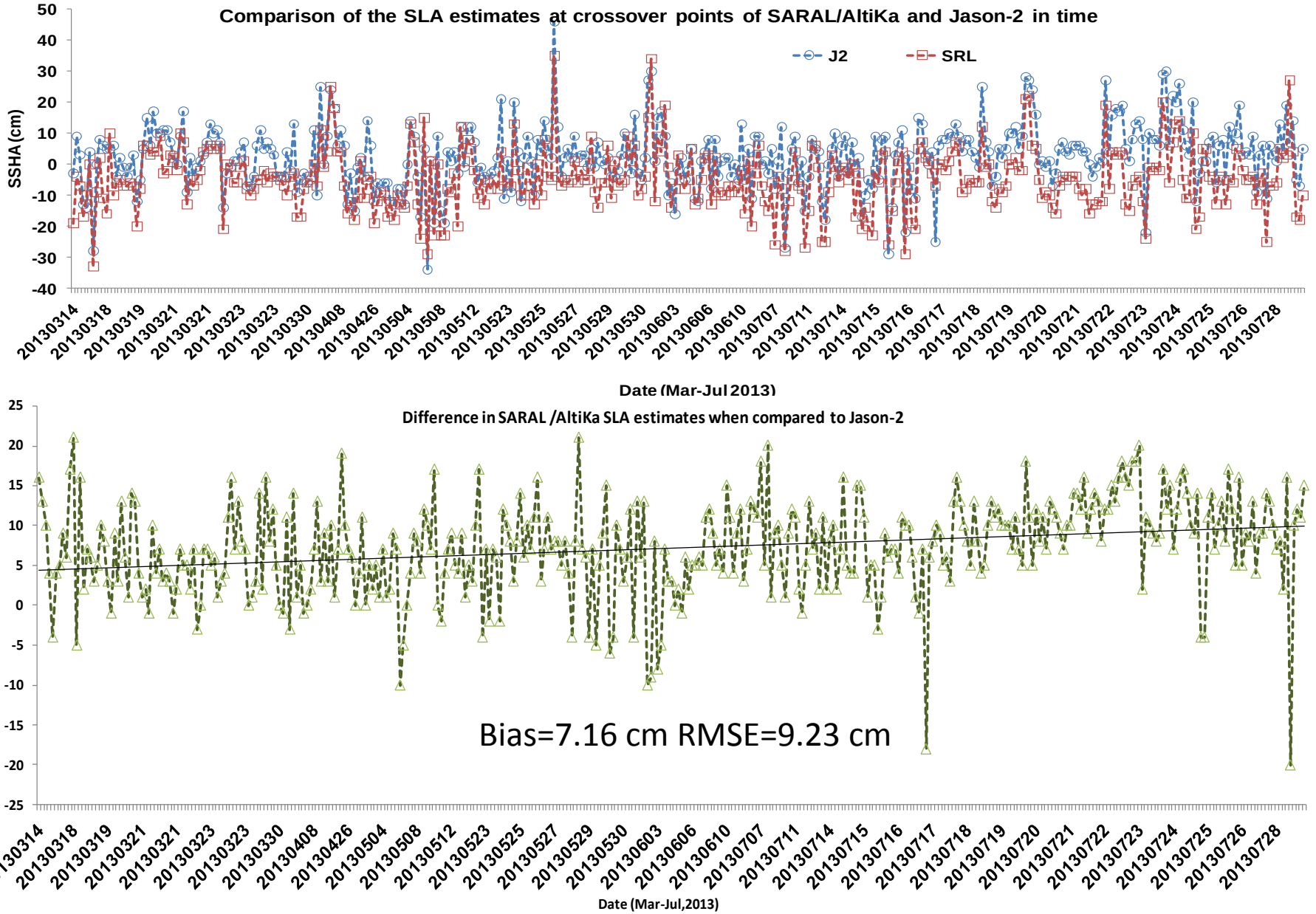


The absolute sea surface height bias of AltiKa over Kavaratti double site

Cycle # (day of pass)	Absolute bias in AltiKa sea surface height (cm)					
	OGDR		IGDR		GDR	
	Main jetty	NIOT Jetty	Main jetty	NIOT Jetty	Main jetty	NIOT Jetty
1 (02/04/13)	2.66	2.49	-3.01	-3.18		
2 (07/05/13)	-2.87	-1.28	-2.09	-0.50		
3 (11/06/13)		-0.56		2.33		

The absolute sea surface height bias between AltiKa and tide gauge observations are meeting the retrieval specifications for the AltiKa OGDR and IGDR products over Kavaratti double site.

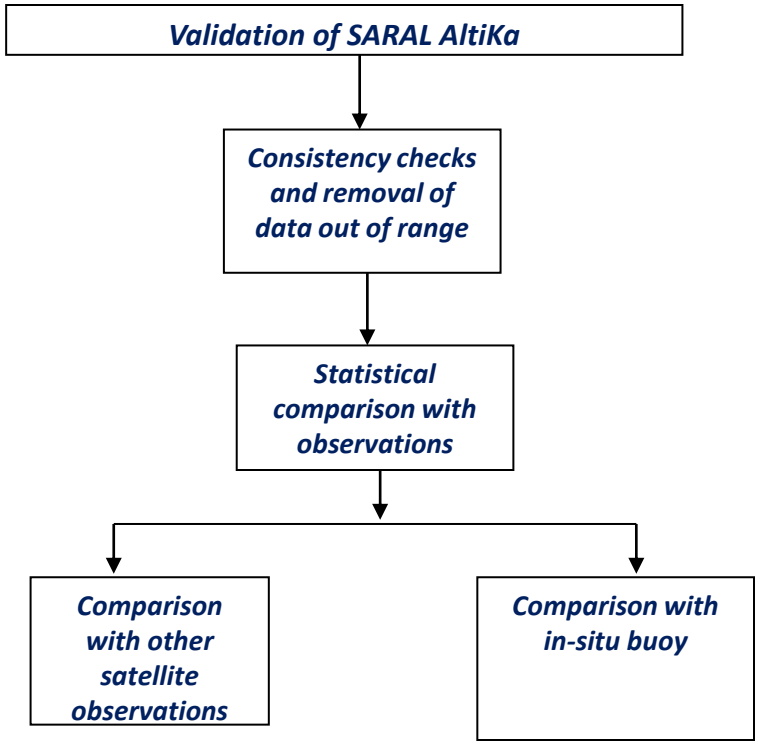
SARAL AltiKa SSHA Cross-Calibration at Crossover points using Jason-2 at OGDR level



Bias of SARAL/AltiKa SSHA is less on an average at crossover points at OGDR level: Representing high quality of measurement.

SARAL /AltiKA Validation

Objective : It aims to assure that the accuracies of the derived products are well within the mission requirement at can be used for various applications study.



Geophysical products validated:

Significant Wave Height

Sea Level Anomaly

Wind Speed

Spatio-temporal collocation criteria for analysis:

- **All data between 50 Km and 30 min of sampling**
- **At cross-over points within 30 min sampling interval**

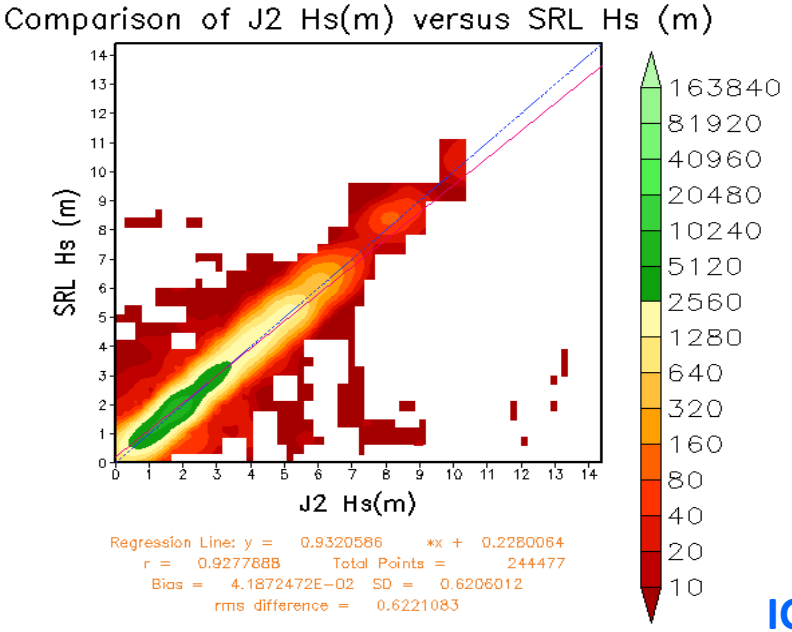
Data From:

In-situ: Wind and SWH from

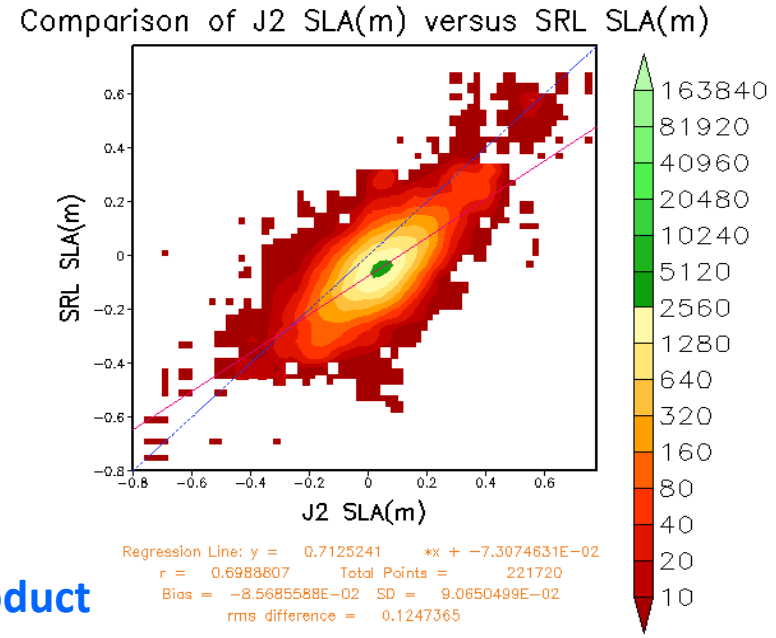
SWH and Wind Speed NDBC Buoys

Satellite: Jason -2 and EnviSAT Radar altimeter data

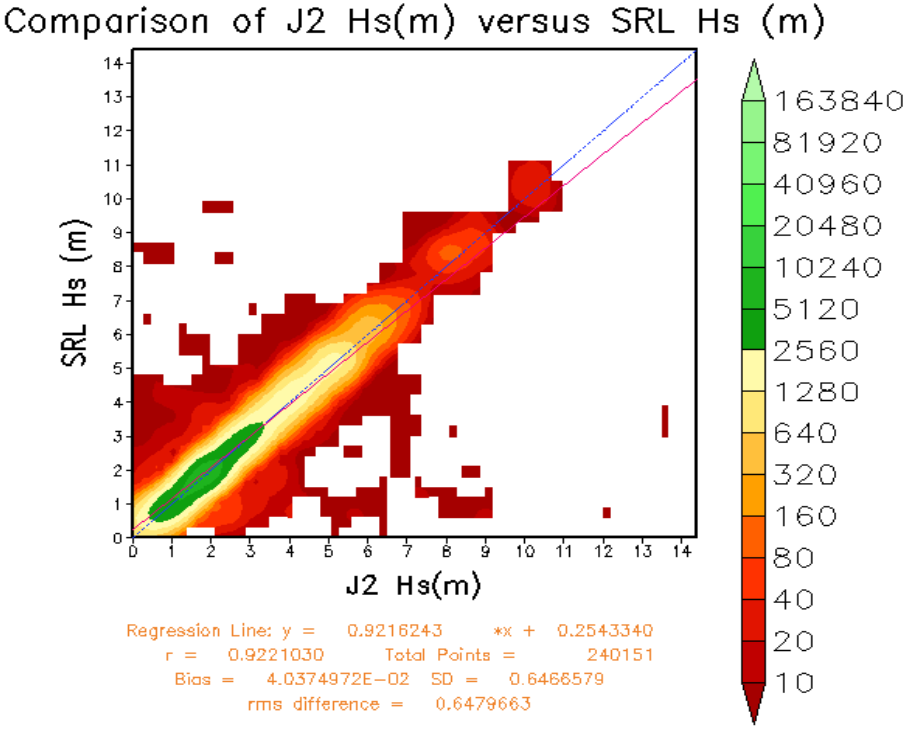
OGDR Level Product

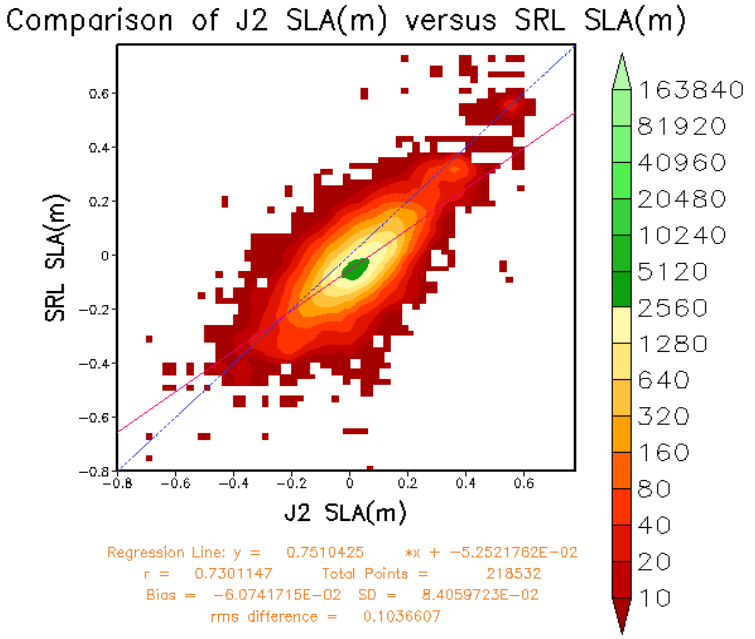


July, 2013

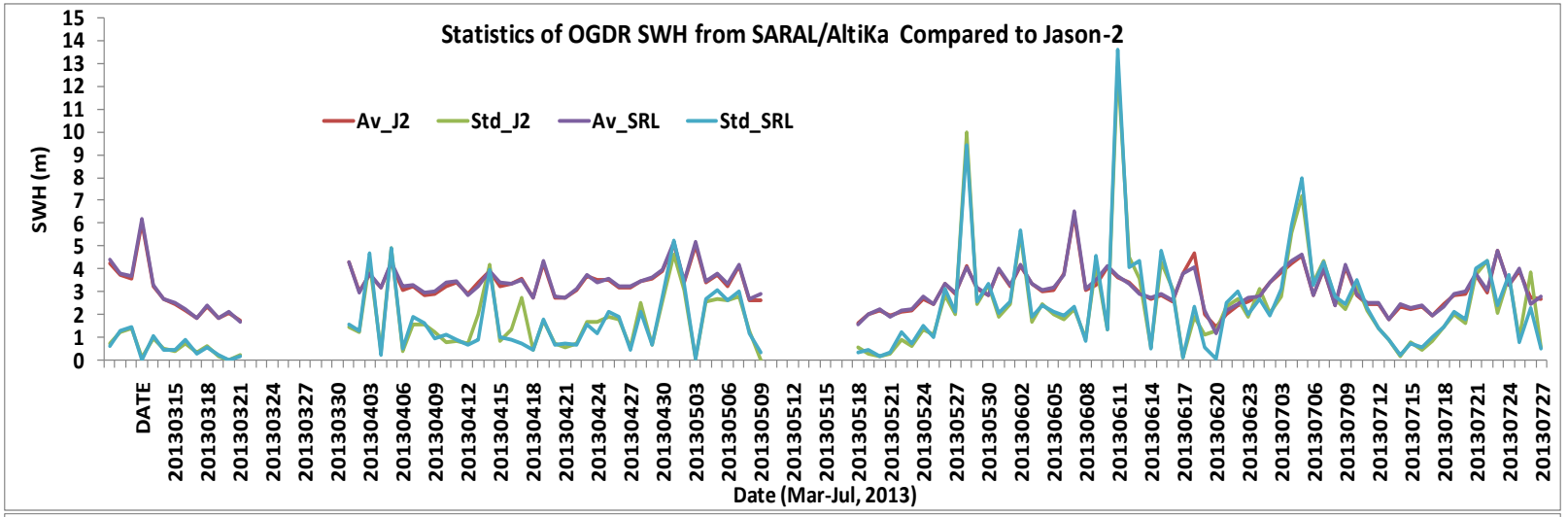


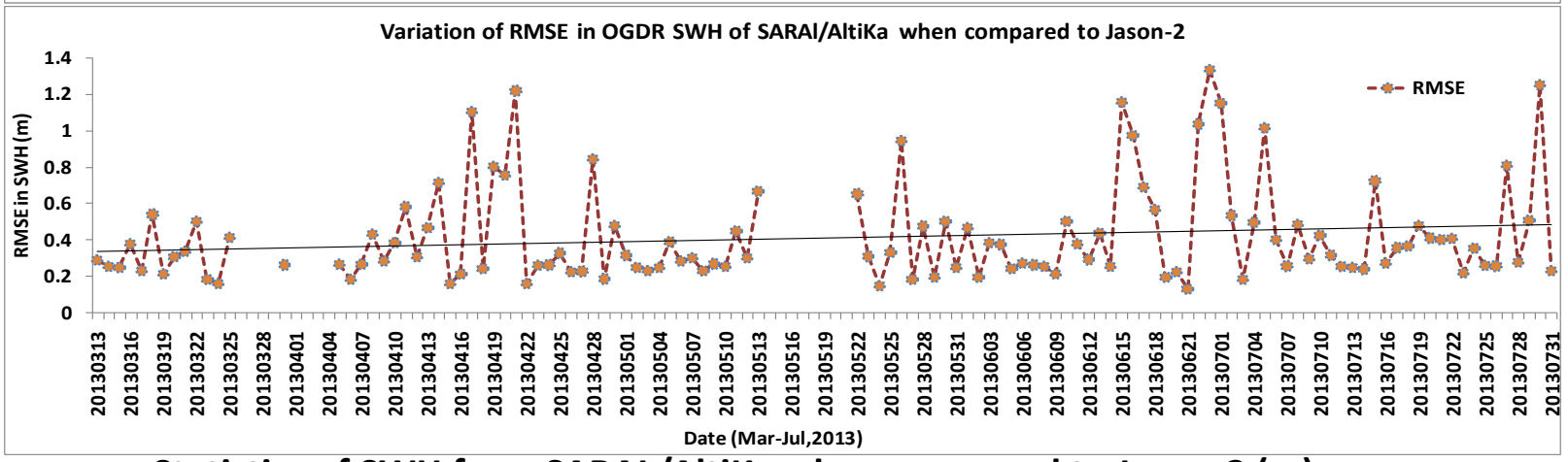
IGDR Level Product





Inter-comparison of OGDR SWH from SARAL/AltiKa and Jason-2

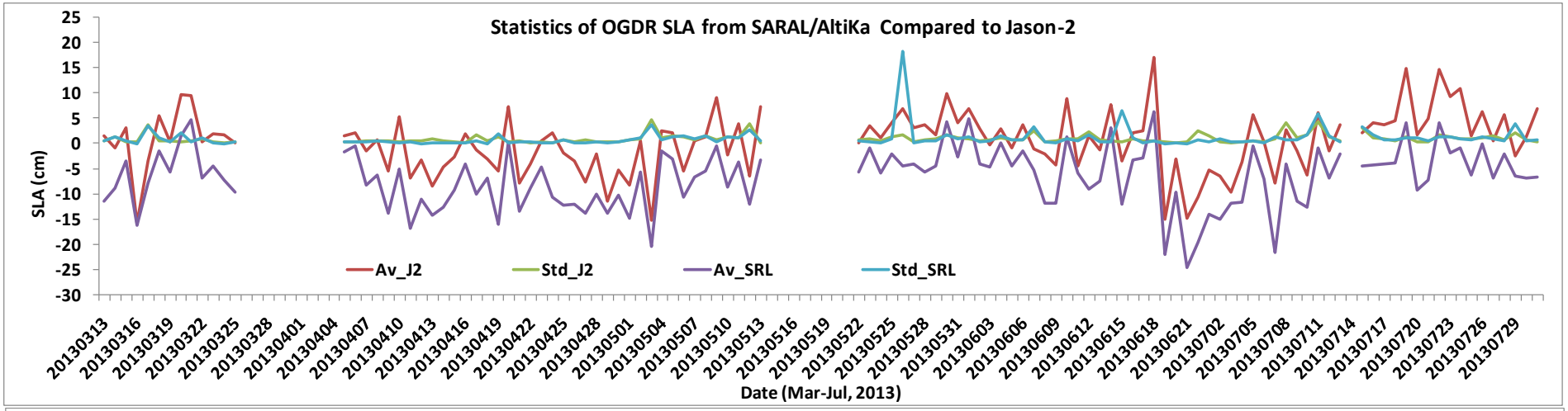


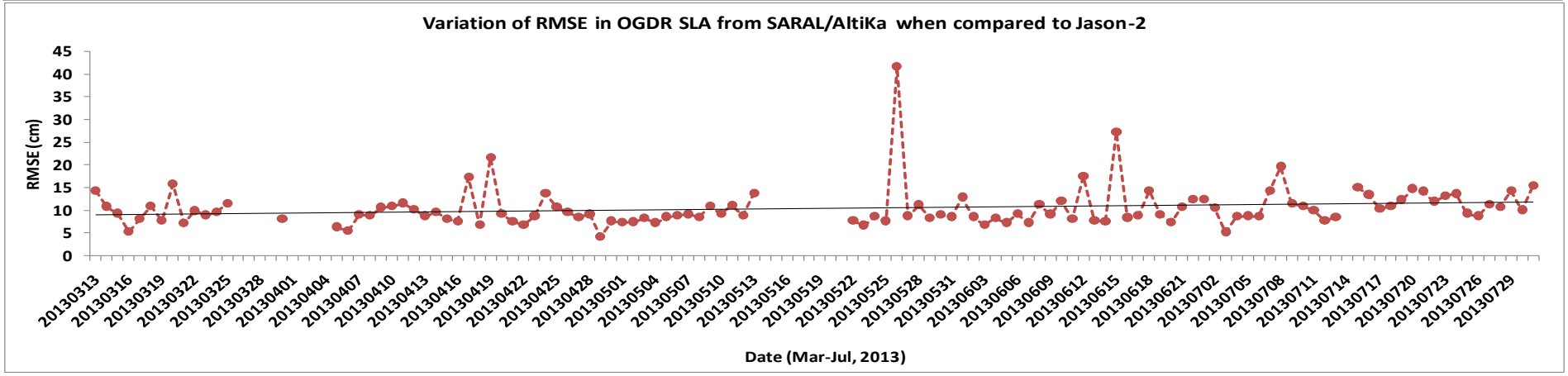


Statistics of SWH from SARAL/AltiKa when compared to Jason-2 (m)

	AV_J2	STD_J2	AV_SRL	STD_SRL	RMSE
MAR	2.41	1	2.46	1.01	0.34
APR	3.4	1.43	3.45	1.4	0.52
MAY	2.77	1.49	2.81	1.53	0.46
JUN	3.42	1.89	3.47	1.91	0.44
JUL	2.73	1.6	2.78	1.62	0.45

Inter-comparison of OGDR SLA from SARAL/AltiKa and Jason-2

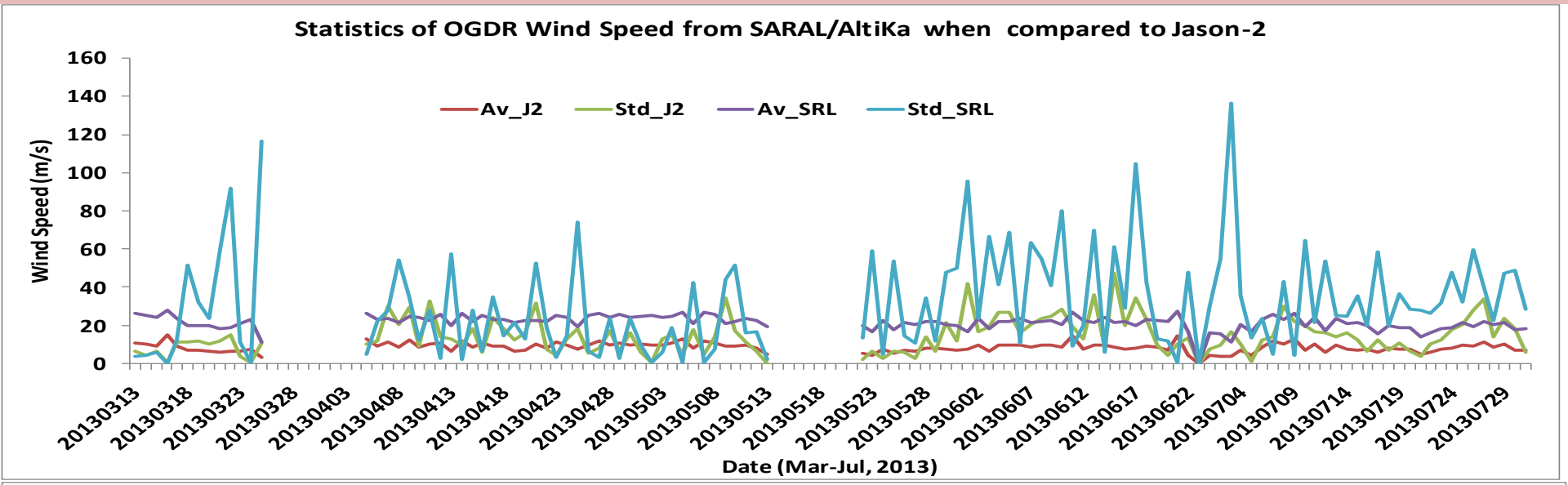


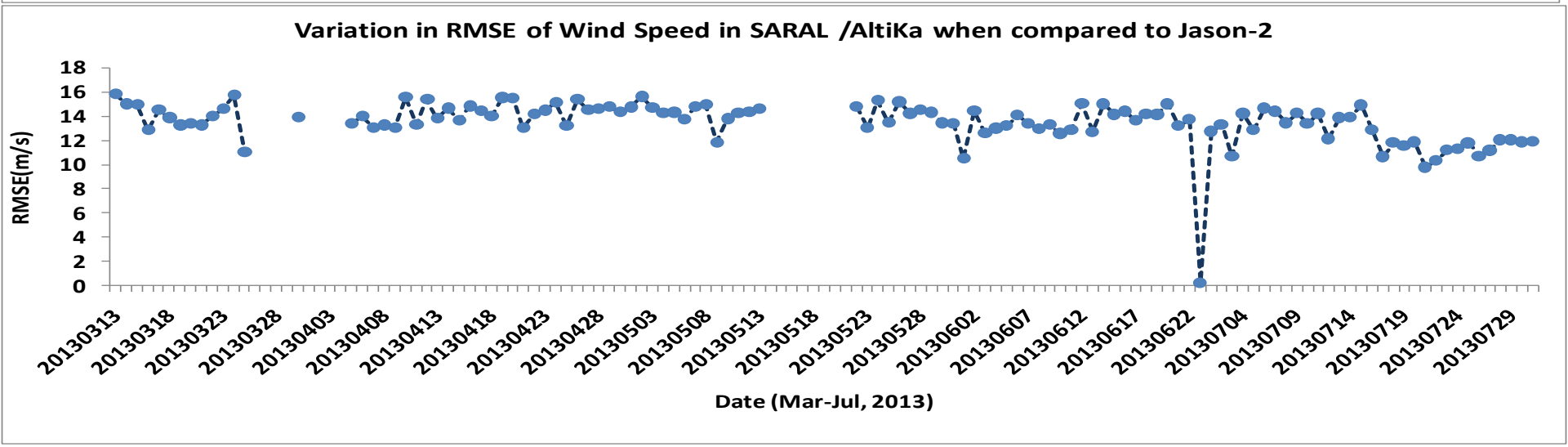


Statistics of SLA from SARAL/AltiKa when compared to Jason-2 (cm)

	AV_J2	STD_J2	AV_SRL	STD_SRL	RMSE
MAR	3.22	9.77	-3.19	10.44	9.48
APR	-2.53	7.51	-9.5	7.55	10.03
MAY	1.67	11.66	-4.96	15.08	13.39
JUN	1.06	10.44	-4.51	11.45	10.0
JUL	4.44	11.56	-4.36	12.12	12.05

Inter-comparison of OGDR Wind Speed from SARAL/AltiKa and Jason-2

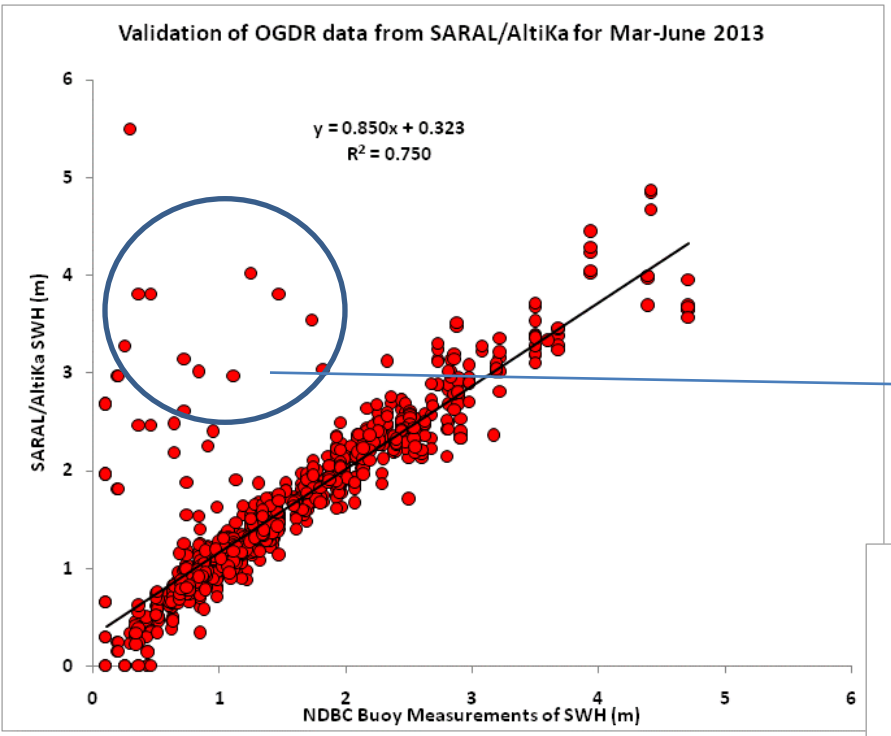


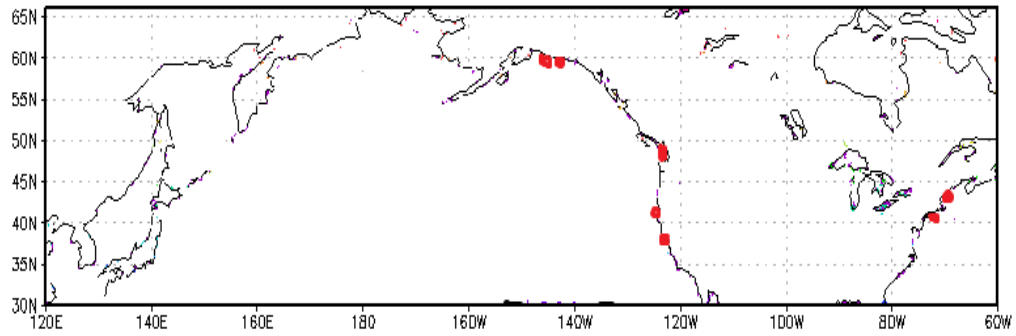


Statistics of Wind Speed from SARAL/AltiKa when compared to Jason-2 (m/s)

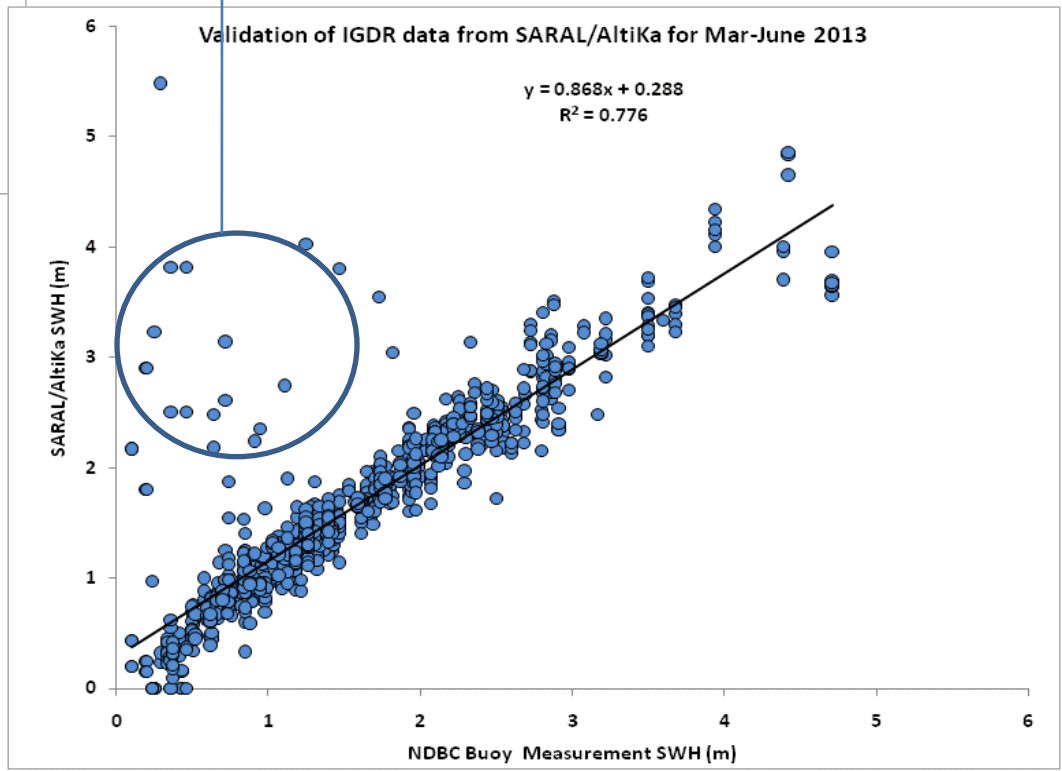
	AV_J2	STD_J2	AV_SRL	STD_SRL	RMSE
MAR	7.04	3.46	20.29	7	13.91
APR	10.04	4.39	23.93	5.12	14.24
MAY	7.77	3.73	21.59	5.89	14.24
JUN	9.11	5.04	21.89	7.37	13.44
JUL	7.78	3.97	19.39	6.38	12.13

Validation of SARAL/AltiKa SWH with NDBC Buoys for month of March, 13 to Jun, 30 2013



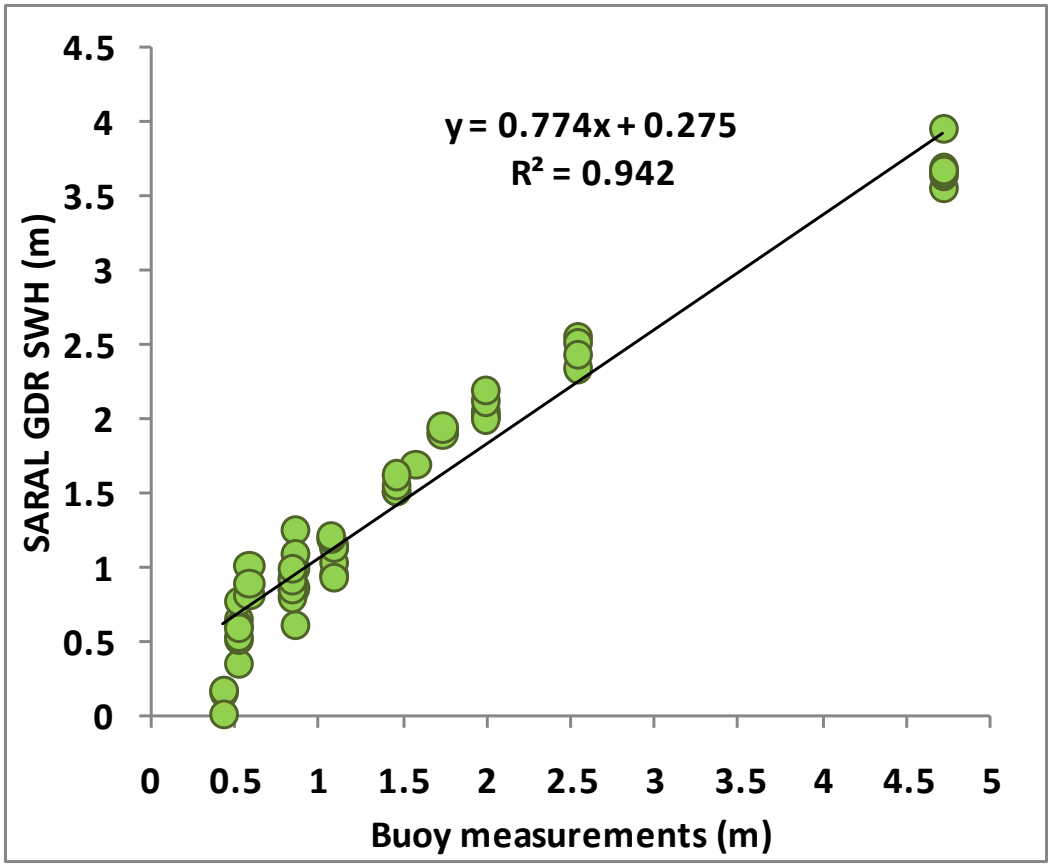


What about these outliers?



Products / Parameters	OGDR	IGDR
BIAS (m)	0.328	0.288
RMSE (m)	0.436	0.417
CORREL	0.86	0.88

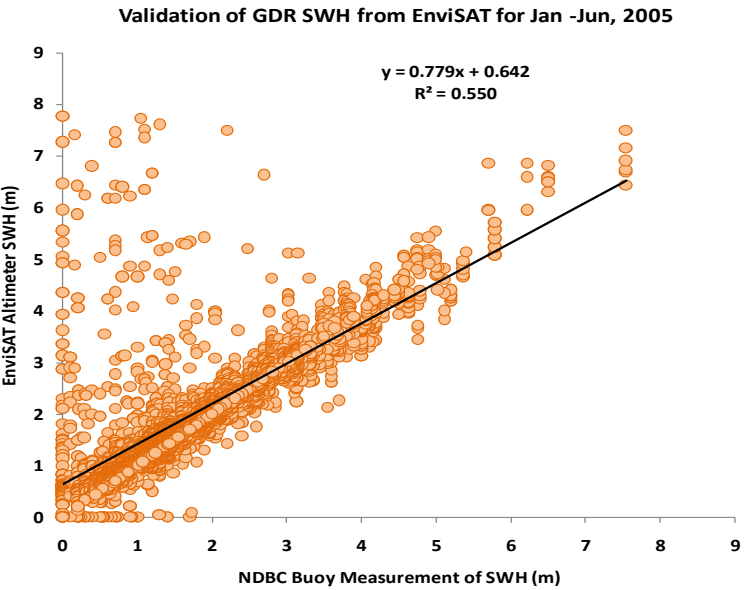
Validation of SARAL/AltiKa GDR products for 13-19, March 2013 using NDBC buoys

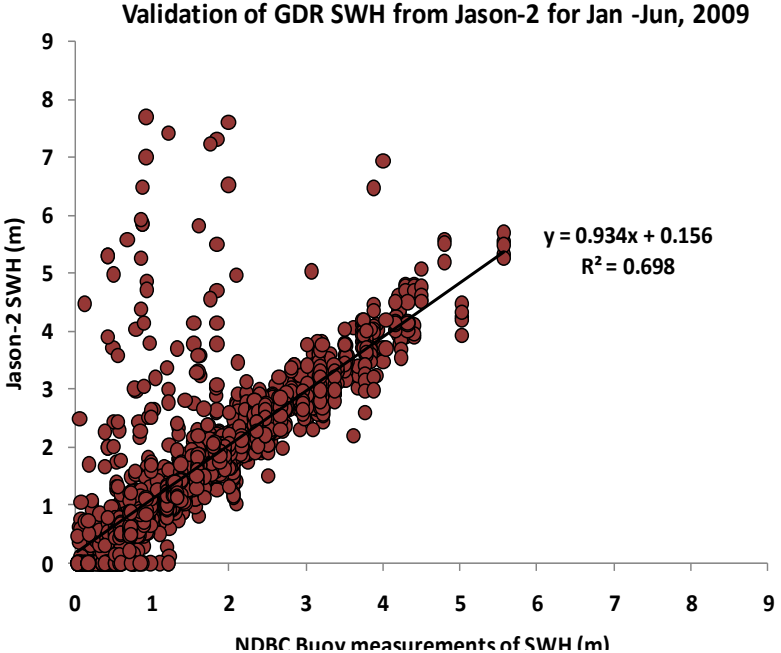


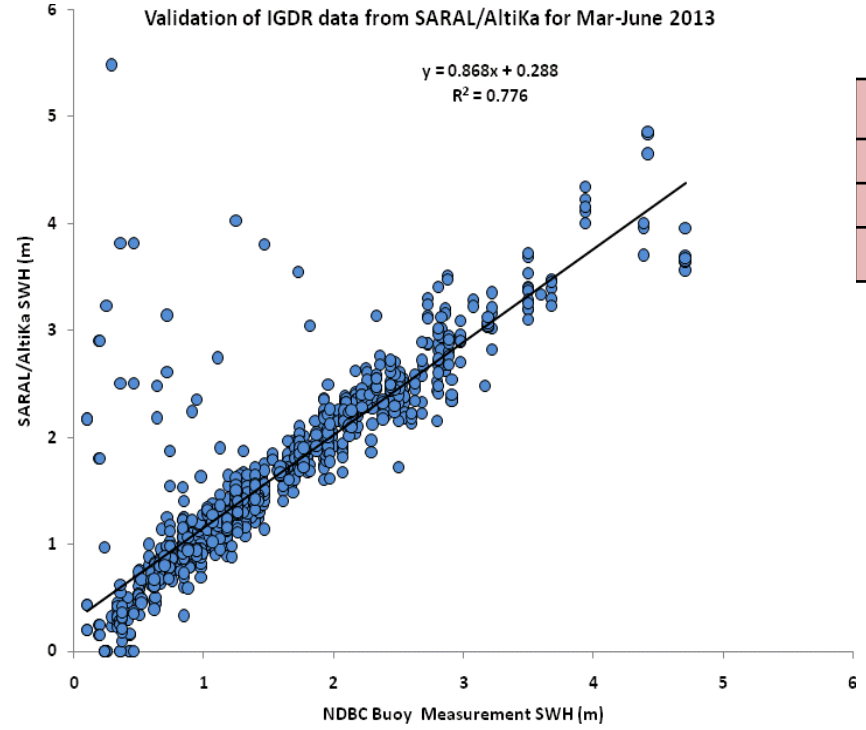
	GDR
BIAS	*0.275*
RMSE	*0.37*
CORREL	*0.971*

The statistics generated with 7 days of GDR SWH shows an improved correlation and bias. However the RMSE is found high which is counter-intuitive. Thus we need more data for validation.

What kind of improvement have we achieved using SARAL/AltiKa over other preceding altimeters ?



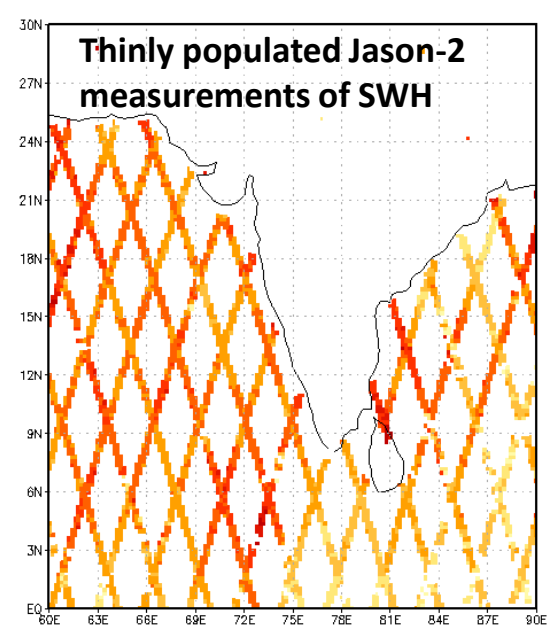


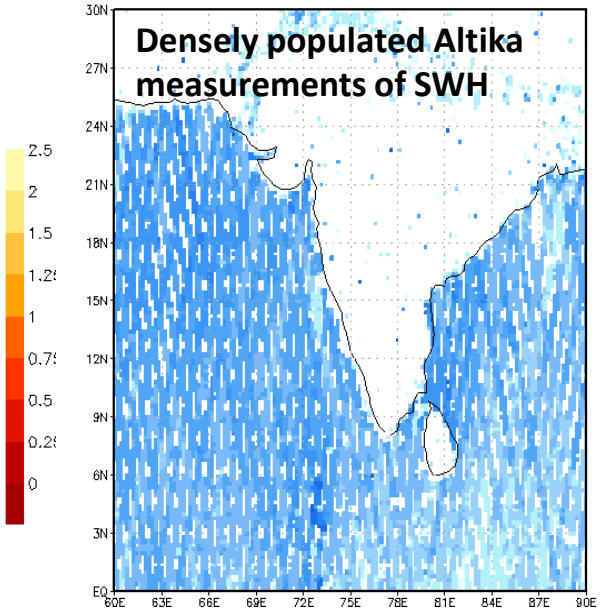


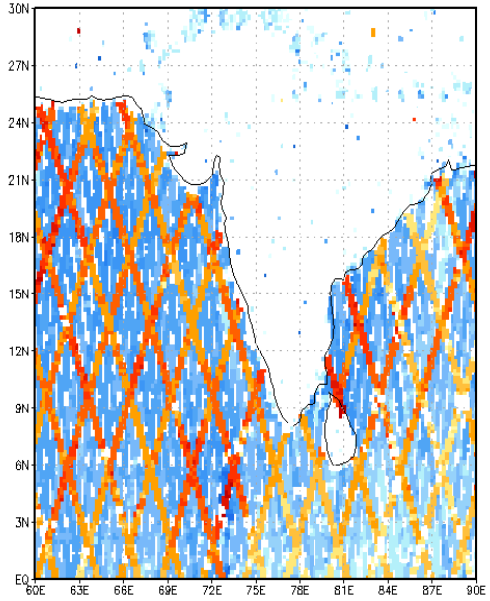
	EnviSAT (2005)	Jason 2 (2009)	SARAL/AltiKa (2013)
BIAS (m)	0.642	0.156	0.288
RMSE (m)	1.07	0.611	0.417
CORREL	0.74	0.83	0.88

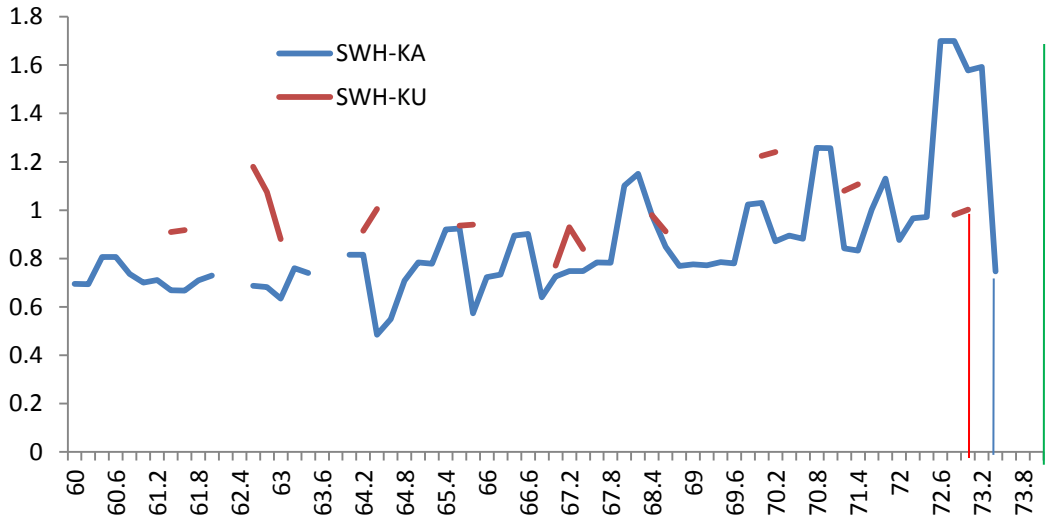
Other Advantage of having SARAL/AltiKa

1. The nearness of Ka band to the coast and it higher density of measurements



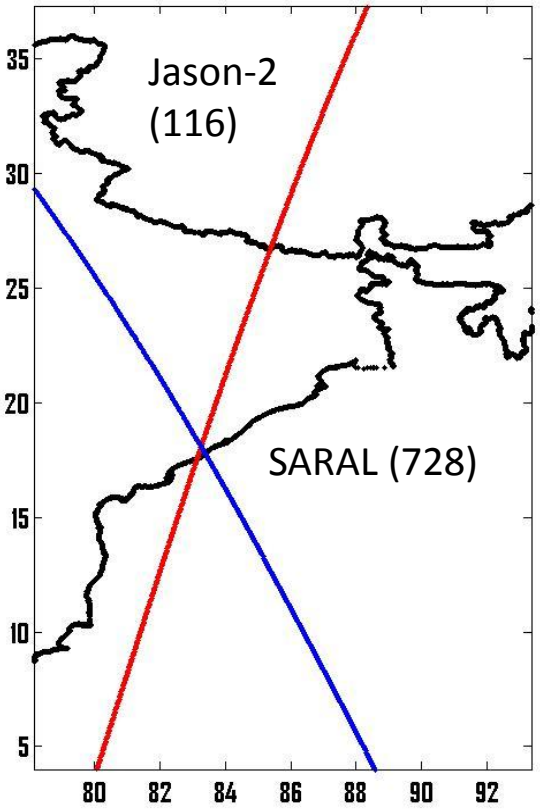


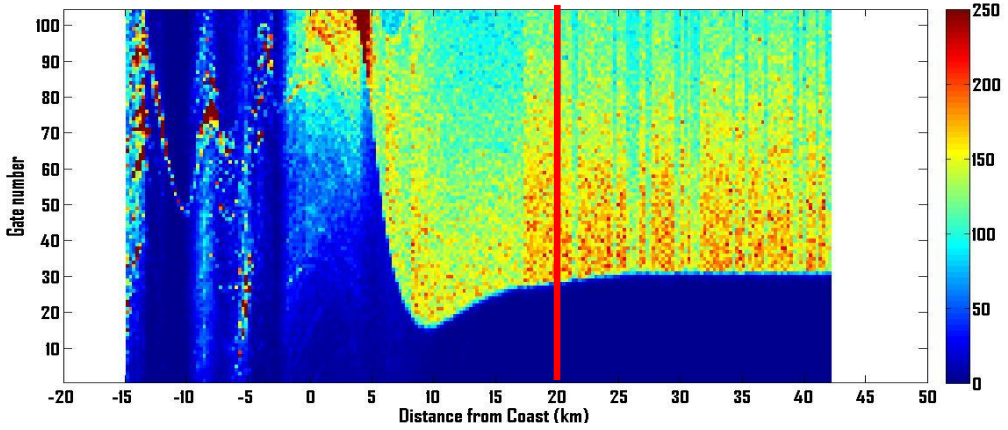


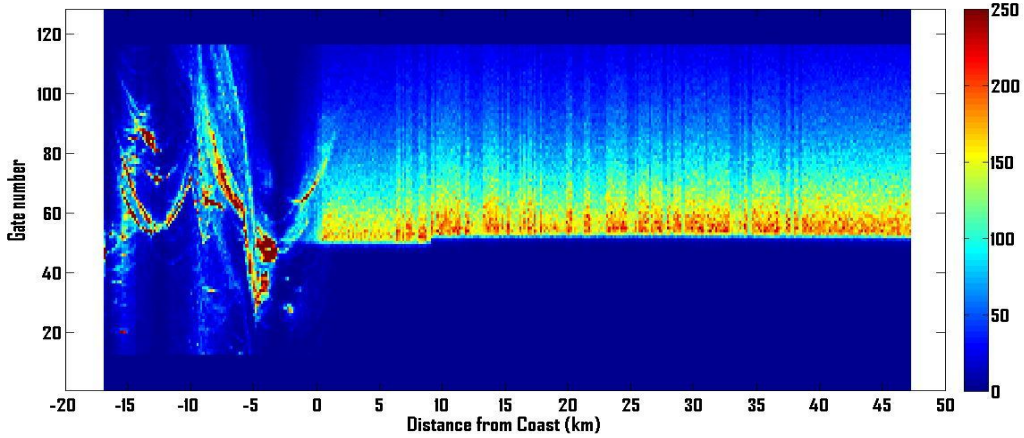


Coastal boundary in Green (73.8 E)
SRL/ALTIKA Blue : 73.4 E
Jason-2 Red: 73E
At this particular location SRL/AltiKa is 40 Km ahead of Jason-2 in terms of nearness to coast.
Data gaps are minimum in AltiKa

Reduction in tracking errors





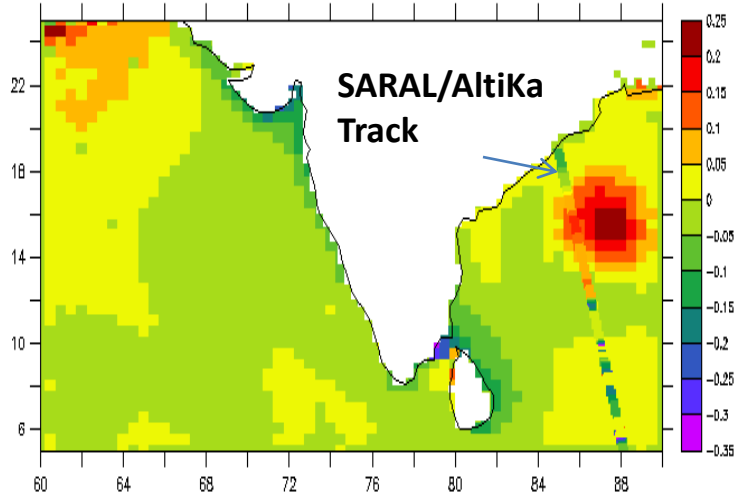


Provided by : Aditya Chaudhury

Predicted SSHA by **Storm Surge Model (ADCIRC)**

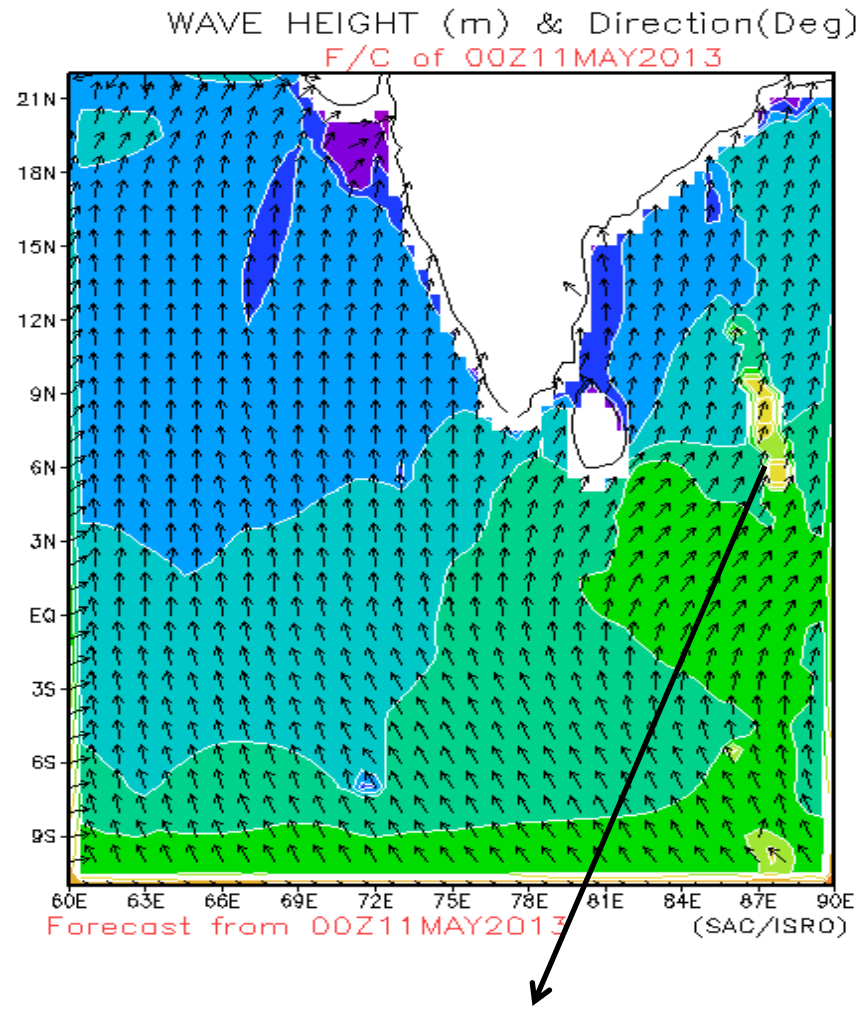
Prediction from 11-May-2013

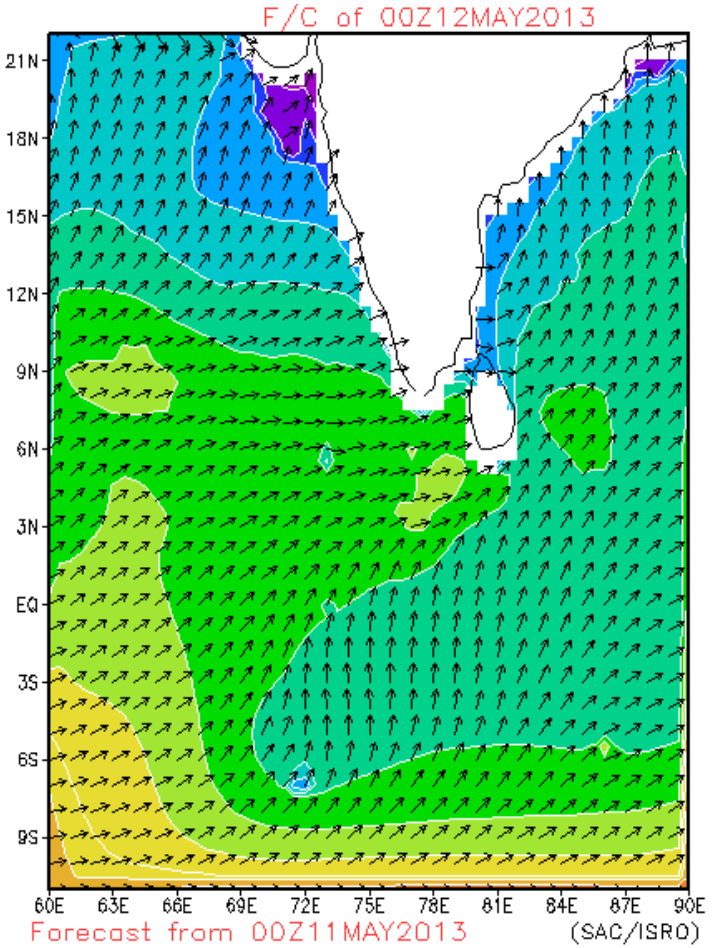
Model Forecast State for 12-May-2013 (00:00 UTC)
Overlay of corresponding SARAL Track for 12-May-2013 (00:15 – 00:22 UTC)



Provided by: Abhishek Chakrobarty

Assimilation of the SARAL/AltiKa tracks in wave model SWAN nested in WAM in operational mode at SAC, ISRO for Indian Ocean Region during cyclone Mahasen (10 May-13 May 2013)

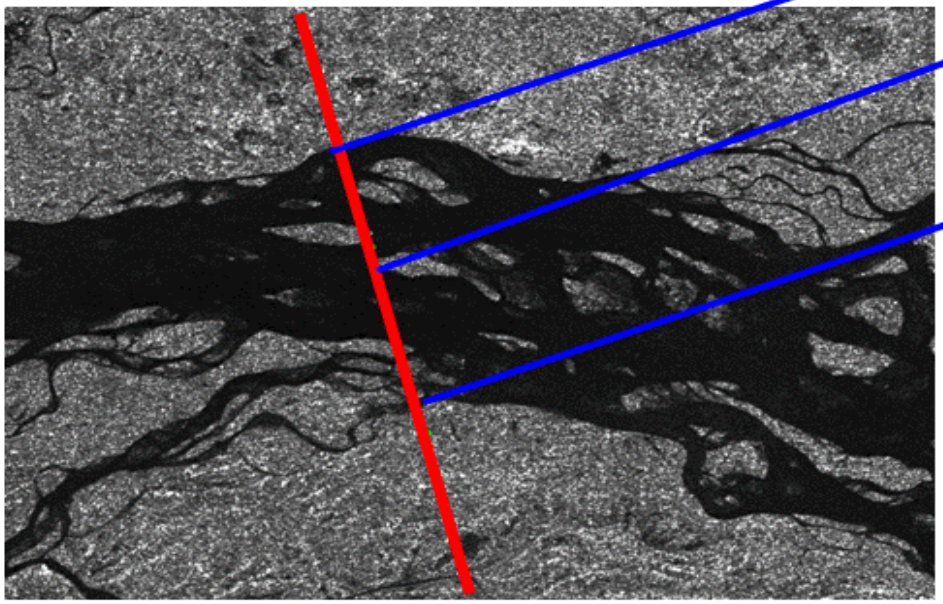


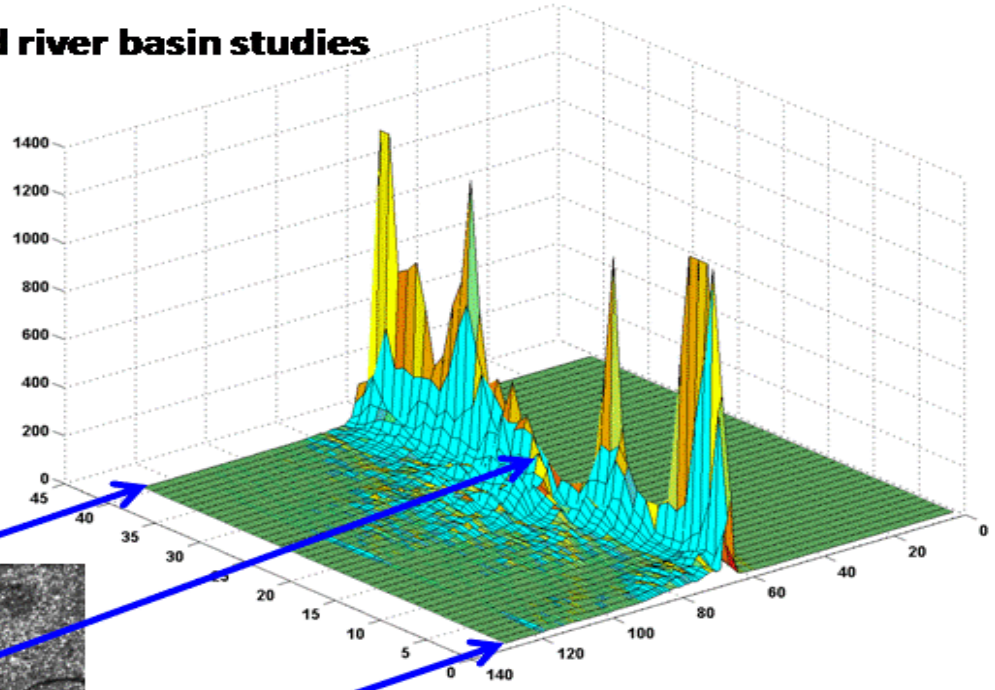


Traces of assimilated SARAL/AltiKa track in analysis hour

Application of SARAL/AltiKa towards inland river basin studies

WAVEFORM VARIATIONS IN A TRANSACT OF THE BRAHMAPUTRA RIVER





Provided by: P.K Gupta

Thanks